A Decade of Cash Flow Testing— Some Lessons Learned

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BIOGRAPHY

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ABSTRACT

The paper outlines the approach that has evolved at Aetna through ten years of cash flow testing. Methodologies and approaches to parameterization are discussed for major invested asset categories, reflecting both default and call/prepayment risk. Modeling of runoff cash flows for a base scenario (and, for some of these assets, shocked scenarios) is also discussed for major non-invested asset categories. Loss reserve cash flow modeling is not addressed, except for a brief description of one approach to shocking these projected flows. Finally, various alternatives are given for presenting the cash flow testing results to management and non-actuarial audiences.

INTRODUCTION

At Aetna in the late 1970s, the concept of asset/liability management was primarily in the domain of the Life Actuaries working in the Corporate Actuarial Department. Their efforts in this area focused on understanding the risks as defined in a 1979 report of the Society of Actuaries committee on Valuation and Related matters: C1 - the risk of loss of value of an asset, C2 - the risk of inadequate pricing of an insurance contract for reasons other than C1 and C3 risks, and C3 - the risk of loss because of variations in interest rates.

While the C1 and C2 risks were familiar territory to the Aetna Life Actuaries, the C3 risk was to some extent overlooked. In a sense, the C3 risk had been lying dormant for many years in an environment of relatively stable interest rates. Then, in the late 1970s/early 1980s, this changed. Interest rates rose to historically unprecedented levels and the C3 risk surged to the forefront in the minds of Aetna actuaries making assessments of insurance company financial strength. Furthermore, in this volatile financial environment, Statutory Annual Statements were simply inadequate for this purpose. The analysis therefore focused on financial strength in its most basic form - during periods of adverse financial and experience conditions, the ability of a company to come up with the cash it needs to meet its obligations.

Under these circumstances, the actuarial efforts to understand the amounts and timing of Aetna's asset and liability cash flows began. In particular, it was recognized that the timing of asset maturities and investment income in relation to liability payments was of significant importance for the Company's Casualty operations as well as its Life operations. With the focus on the underlying economic strength of the balance sheet in the face of the C3 risk category, the first property/casualty "mismatch" analysis was completed in July of 1982. The analysis took the form of a cash flow runoff of the Company's 12/31/81 balance sheet.

Since then, the analysis has been performed annually, and the scope has broadened beyond the original mismatch risk (i.e. interest rate risk) focus. The analysis now includes default and prepayment risk on bonds, default and refinancing on mortgages, certain off-balance sheet risks, and reserve development risk. Over the years, the results of the analysis have been presented to senior management and to rating agencies. The analysis has also been used by Aetna's portfolio managers as a tool in understanding the cash needs of the business and in managing the degree of mismatch between the asset cash flows of their portfolios and the cash flows of the liabilities.

Our paper will focus on how we have modeled expected asset cash flows (following Annual Statement Page 2 line categories) and the approach we have taken to "shock" certain asset categories to reflect defaults, prepayments, and refinancing (for mortgages). For non-invested assets, the discussion will be brief except for the accrued retro premium account (line 9.3). For this item we will discuss how we tie it to the loss assumptions.

Certain items on the liability side will also be discussed, but in keeping with the subject of the discussion paper program these will not be emphasized. We will discuss briefly how we model the emergence of possible adverse loss development, and how we handle the runoff of the UPR and similar items. Other liability items will be touched on only in a cursory fashion, including how we have modeled tax flows.

INVESTED ASSETS

Reflecting on our cash flow analysis and the best description of how it begins each year, the key words that emerge are communication, communication, and communication. Reserve issues are identified through discussions with our P/C reserve actuaries, cash flow methodology issues are discussed and peer review is solicited from our Life actuaries, and most importantly in the context of this paper, invested asset issues are identified and discussed with our portfolio managers. Through these discussions, the focus of the analysis takes shape and the key questions to address though the analysis become well defined. Also through these discussions, the detail in which the cash flows are modeled is adjusted if necessary depending on whether there are any significant unique (in terms of cash flow) items buried in the asset or liability categories of the balance sheet.

For the invested assets, we look to the portfolio managers as the experts. We rely on them to provide the asset cash flows under various scenarios constructed with their advice and guidance.

BONDS (EXCLUDING MORTGAGE BACKED SECURITIES)

Prepayment/Calls Risk

Following the discussions mentioned above, the bond cash flows are provided to us by the portfolio managers under three prepayment scenarios reflecting a range of possible interest rate conditions. The scenarios include a baseline that reflects the projected cash flows under current interest rate expectations, a "shortest probable" scenario that would reflect the largest volume of prepayments that would be expected if interest rates dropped, and a "longest probable" scenario that would reflect the least volume of prepayments that could be expected if interest rates rose.

1. Base Case Cash Flow

   Callable bonds are assumed to call (or prepay) if the coupon exceeds 150 basis points of projected treasury returns[1].

2. Shortest Probable Cash Flow

   All callable bonds call at the earliest opportunity.

3. Longest Probable Cash Flow

   Bond cash flows follow prescribed sinking fund schedules/maturity dates (pre-refunded bonds are assumed to prepay).

The primary focus of the multiple scenarios is not any one scenario, it is the range of results that will be produced when the different cash flows are combined with the other balance sheet cash flows in our model.

Therefore, the key to reflecting prepayments in our bond cash flows rests with the modeling capability of our portfolio managers. Currently, the database they maintain contains specific contractual terms of each bond held - whether there is a call provision, the maturity date and coupon rate, and several other data fields. Also, the database with its associated software has the scenario capability to modify the cash flows in response to specified criteria.

[1]For the 1993 analysis, interest rates were assumed to rise through 1998 and then remain level (150 basis point criterion is specific to the composition of our portfolio).

Default Risk

The bond cash flows described in the preceding paragraph exclude bonds already in default, but make no allowances for future defaults. Obviously some additional allowance must be made. Our current methodology does this by first determining a default rate, and then shocking the bond cash flows for various multiples of that rate. An additional adjustment is made for recoveries from bonds in default.

1. Selecting a default rate

   We currently utilize three different methods to produce such a rate, and then make a judgmental selection.

   The most scientific of our methods is based on the work of Edward I. Altman, in his paper called Default Risk, Mortality Rates, and the Performance of Corporate Bonds [1]. The principal message in his paper is that default risk is partly a function of time. Bonds rated AAA default less frequently than bonds rated BBB, but the longer into the future ones goes the more likely it is that today's AAA bonds will default. This makes intuitive sense, as no rating agency would rate a bond AAA if it faced significant default risk today, but over time even strong companies can become weak and default.

   Altman included in his paper a table of cumulative default rates by current bond rating and lag year[2]. This table is updated annually in a report published by Moody's Investors Service [2]. Ideally we would apply this table of default rates, by bond rating and lag year, to our bond cash flows, by bond rating and lag year. Instead we have resorted to a simpler calculation, whereby we use Schedule D, Part 1A data to

[2]For example, for bonds currently rated A, he shows the probably of default in one year, in two years, etc.

produce weighted average portfolio default rates by lag year (see Appendix A for more details). This seems to produce reasonable numbers for about 14 lag years, but the data underlying the default tables was found to be too sparse beyond then.

The next method we use is analysis of our own historical bond default rates. This approach serves as a reasonability check on the previous method's result, as well as possibly quantifying the value added by our own investment department (in their independent analysis of borrower credit risk).

After completing the analysis for the two methods described above, we are ready for a discussion with our investment department. We discuss our findings vis-a-vis default rate assumptions, ask them what they think a reasonable default rate is (as our third method), and select a final estimate.

We currently apply the same default rate assumption to every year of our bond flows. This is somewhat counter to the lessons learned by Altman, whereby default rates should gradually rise over time. Our response is to pick a rate that is conservative for the first several years, in line with what we believe the default rate will be for the middle to later years.

2. Applying the selected default rate

After choosing the annual default rate assumption, we apply it to the outstanding bond principal at each year end as modeled in the earlier Prepayment/Call risk section. We track the cumulative amount of total outstanding principal defaulted for each year, and assume the interest flow is reduced in the same proportion. For example, if we assume a 2% default rate in years 1 and 2, then we assume that 4% of year 2 interest disappears.

3. Default recoveries

When a bond defaults, it is rare that creditors lose all of their investment. The Moody's report referenced above also includes an analysis of ultimate recovery rates, i.e. how many cents are recovered per dollar of principal owed. Default recovery rates calculated this way are generally between 40 and 60%. We combine general data from such sources with input from our investment department to select a recovery rate.

The selected recovery rate is then applied to defaulted principal, and a lag of two years between year of default and year of recovery is used to model the default recoveries.

BONDS - MORTGAGE BACKED SECURITIES

Prepayment/Calls Risk

Mortgage Backed Securities are instruments whose cash flows depend on the cash flows from an underlying pool of Mortgages. Because of this, the mechanism driving prepayments is different from other bonds and so our portfolio managers model these assets separately. Our discussions with our portfolio managers have focused primarily on Mortgage Pass-Through Securities and Collateralized Mortgage Obligations (CMO).

The Handbook of Fixed Income Securities[3] states:

> "The cash flow for each class of CMO can be derived only by assuming some prepayment rate for the underlying mortgage collateral. The prepayment benchmark

used by mortgage backed securities dealers to quote CMO yields is the PSA (Public Securities Association) standard prepayment model."

From Mortgage Banking (January 1990)[4]:

"A mortgage pool whose prepayment experience conforms to the PSA pattern is said to prepay at 100 percent of the PSA model. Any slower or faster prepayment speed is a fraction or multiple of that PSA model."

From about 1989 to 1992, our portfolio managers used the PSA method to produce cash flows for our different interest rate scenarios[3]. In those years, we used 100% of PSA for our base case cash flow, ten times PSA for a scenario reflecting a significant drop in interest rates (i.e., high prepayments - comparable to the "shortest probable" bond scenario), and 50% of PSA for a scenario reflecting a rise in interest rates (i.e., low prepayments - comparable to the "longest probable" bond scenario).

However, in 1992 interest rates fell significantly and as our discussions with the portfolio managers progressed (in early 1993), we were made aware that the PSA based model was not doing a good job of modeling the volume of prepayments that were being observed on our CMOs. With preliminary analysis results already in hand, our portfolio managers provided us with new cash flows for the CMOs. Reflecting the heavy volume of prepayments, the new flows showed substantially more cash in the early runoff years, and substantially less in total. Interestingly from the perspective of our runoff analysis, this actually strengthened our financial position, with respect to interest rate risk at least, because the new asset cash flows were more well matched to our liability cash flows.

[3]They also had the capability to develop expected prepayment rates based on the specific characteristics of each security held. The expected rate reflected two classes of factors - 1. demographic turnover (factors related to the personal characteristics of the mortgagor, e.g. people tend to move on after a certain number of years), and 2. refinancing activity (factors reflecting the economic motivation of the mortgagor).

Our portfolio managers continue to provide us with the asset cash flows and prepayment scenarios reflecting separate treatment for mortgage backed securities. However, the modeling techniques for these assets have been changing since the need to do so was made clear during the 1992 cash flow analysis. For our 1993 analysis, our three mortgage backed security cash flow scenarios were developed according to the following interest rate assumptions:

1. <u>Base Case Cash Flow</u>

   Interest rates remain at current levels.

2. <u>Shortest Probable Cash Flow</u>

   Interest rate decrease 300 basis points from current levels.

3. <u>Longest Probable Cash Flow</u>

   Interest rates increase 300 basis points from current levels.

In determining these scenarios, we asked the portfolio managers for the "<u>longest</u>" and "<u>shortest</u>" cash flows that they would consider possible in the context of changing interest rates (as well as their current base expectation). In their judgment, the 300 basis point range produced the cash flow effects (on our portfolio) consistent with our request.

Our experience with mortgage backed security prepayments highlights a crucial point that applies generally to all our cash flows, and to modeling generally: past methods, or past experience that produced reasonable estimates in the past, may not produce reasonable estimates in the future. Again, the key to ensuring the validity of the modeled asset cash flows is communication with those who are managing the assets. They will know if economic conditions are producing asset behavior that is unexpected or differs significantly from past models.

Default Risk

For purposes of default, we have not at this point developed a separate approach (or rate) for mortgage backed securities. The cash flows for these assets are aggregated with those of our other bonds and the default methodology described earlier is applied in our model.

This is consistent with how the bond default selections were made. The analysis using bonds by NAIC rating class included all bonds, mortgage backed and otherwise. Therefore we believe that, in total, our bond default assumptions are reasonable. The default assumptions should vary, however, if separate assumptions are to be made for mortgage backed bonds versus non-collateralized bonds. This is because many mortgage backed securities include government agency guarantees (e.g. Ginnie Maes) with minimal, if any, default risk.

This aggregation of all bond types for default risk purposes does raise one additional important issue, namely the importance of defining in advance the scope of the investment department discussions. Investment departments may not be organized in line with Annual Statement Page 2 asset categories. Separate departments may exist for private vs. publicly traded, mortgage backed vs. non-collateralized and/or government vs. corporate bonds. Management of other asset types may see similar segmentation. When discussing an asset risk parameter, care should be taken that all relevant portfolio managers are represented. Otherwise one might find that the value selected to measure asset risk is reasonable only for a small segment of the assets in question.

MORTGAGES

Prepayment/Calls Risk

As for bonds, we have looked to our portfolio managers for the expertise in modeling prepayment behavior on mortgages. For mortgage prepayments, it would be an understatement to say our discussion on this issue was very short. In fact, when we raised the question of prepayments, our portfolio managers looked quizzically at each other momentarily and then answered ... "mortgages don't prepay".

Of course, they were not talking about residential mortgages. They were speaking in relation to our portfolios of commercial mortgages. Because commercial property owners with mortgages will pass the cost of their mortgage debt through to their renters, the prepayment behavior of these assets is different, and in fact they tend not to prepay. This tendency is separate from the fact that in the current economic climate for commercial real estate, it would probably be difficult for a commercial mortgage loan holder to refinance even if they wanted to.

The significant issues in modeling commercial mortgage loan cash flows are default (and refinancing), and the underlying property values.

Default/Refinancing Risk

Our default analysis starts with the mortgages' contractual flows, with principal and interest flows separated, and balloon principal separated from other scheduled principal. Unfortunately, in the current economic environment the contractual flows are probably not what is expected, particularly for balloon mortgages. Therefore, our portfolio managers adjust the contractual mortgage flows to the extent that the actual flows are expected to differ from the original contract terms.

The portfolio managers' adjustments are for specifically identified problem or near problem loans. Adjustments include refinancing loans (in which case our receipt of principal is delayed but we receive more interest payments), retiring the loan but at a reduced amount, and foreclosure.

The refinancing risk manifests itself primarily on the balloon mortgages. For these mortgages, scheduled payments are interest only and the entire principal balance (the "balloon") is due upon maturity, and for commercial mortgages the balloon can be <u>very</u> large. Typically, the borrower never expected to pay off the debt, but instead to continually roll it over, i.e., pay off the balloon with proceeds from a new loan. This may have worked during the real estate craze of the 1980s but when real estate values dropped and credit tightened, these borrowers found that they could not obtain the refinancing they originally planned. As lenders we are left with a choice, either foreclose or extend the loans.

Note that the flows adjusted by the portfolio managers reflect defaults but only to the extent that defaults are known or considered likely on specific mortgages. In the language of asset impairment reserves, specific impairments are reflected, general impairments are not. Therefore, to arrive at our base case mortgage cash flows including future default risk, we apply a selected default rate to the cash flows. The algorithm used to model the defaults is the same as described earlier for bonds. However, the assumptions on default rate, the recovery rate, and the lag between default and recovery must be reviewed and changed if appropriate.

For the recovery rate and lag, we have generally taken a fairly "broad brush" approach. These assumptions have simply been selected based upon discussions with the portfolio managers (generally, we look for assumptions that they judge to be reasonable but on the conservative side). For the selection of the default rate, we test the effects of various default rates, and then discuss the reasonability of the various impacts with the mortgage portfolio managers. One perspective that we have found helpful in discussing the impacts is in terms of the reduction to the all time yield (in basis points) of the portfolio as implied by the cash flows. This can be measured by calculating the internal rate of return of the flows, before and after application of the default rate (all you need is the beginning outstanding principal and the cash flows).

With the base case mortgage cash flows set through this process, more adverse scenarios of mortgage experience are modeled by shocking the flows at multiples of the base default rate.

OTHER INVESTED ASSETS (Including Stocks)

Other invested assets included cash and short term investments, stock, and real estate. For us, these assets are small in relation to the bonds and mortgages and our approach to modeling them is correspondingly simple. Generally, we have just assumed that these assets are converted to cash in the first year of the runoff[4].

One exception deals with real estate. It may not be reasonable to assume that real estate can be sold within a year. Therefore, in our most recent analysis we differentiated between investment grade and foreclosed real estate and assumed that the latter produced a three year cash flow at less than the current GAAP value.

[4]Transaction costs of the sale could be reflected through a reduction to the assumed cash flow.

In evaluating these asset categories it is important to keep in mind that we are performing a runoff analysis, NOT A FIRE SALE. This should be considered before one starts to convert occupied real estate and stock of affiliates to cash. We do not reflect any cash flows from these types of assets in our analysis. This is true for non-invested assets like furniture and equipment also.

NON - INVESTED ASSETS

For non-invested categories, most assets fall under Annual Statement line 9 - Agents Balances, Line 12 - Reinsurance Recoverable on Loss Payments, and Line 15 - Interest, Dividends, and Real Estate Income Due and Accrued. With the exception of the Accrued Retrospective Premiums, Line 9.3 (and a related portion of line 9.2), we have taken a simple approach and assumed that the cash is received in the first year of the runoff. We have not performed any analysis of collection risk associated with these items, relying instead on statutory non-admitted asset rules and Schedule F penalties to reflect collection risk. Also, as mentioned before, we do not reflect any cash flow for items such as property and equipment.

Accrued Retrospective Premiums (A.S. Page 2, Line 9.3)

As a large commercial lines writer of retrospectively rated policies in the Auto, GL, and Workers' Compensation lines of business, this has been a significant item for us. In our analysis, we group this asset with our liabilities (showing it as a negative outflow) since the expected additional premiums are directly connected to the losses on this business. There are two aspects of the expected cash flows that we will discuss here: 1. the runoff of the held retro premium reserve, and 2. adverse loss development scenarios.

1. <u>The runoff - Lines 9.3, 9.2, and 9.1</u>

   An issue that we have addressed when projecting how the accrued retrospective premium asset runs off is this: modeling the runoff of this asset is not the same as modeling cash receipts.

   The retro premium reserve represents future premiums to be written as reported incurred losses (paid plus case basis reserves) develop on retrospectively rated policies. As the losses emerge, the additional premium is booked and then billed (i.e. there is a shift - line 9.3 goes down and 9.1 goes up), and then the cash is received after a lag. However, on our book of business it is not this straight forward. This is because for some retro policies, the amount of premium booked is based on reported <u>incurred</u> losses, but the amount billed is based on reported <u>paid</u> losses. In this case, line 9.3 goes down by the amount booked, line 9.1 goes up by the amount billed, and line 9.2 goes up by the difference between the booked and billed premium (for statutory accounting, the amount in line 9.2 must be secured by a bank letter of credit or other collateral, otherwise it is non-admitted).

   The important point here is that to appropriately reflect how the retro premium asset converts to cash (and also how line 9.2 becomes cash), it is necessary to understand the various billing arrangements available to the insured. In our case, the cash is received more slowly than a pure runoff of the line 9.3 asset would indicate.

2. <u>Retro premiums and adverse loss development</u>

   While not a focus of this paper, adverse loss development scenarios are a major focus of our cash flow analysis. To model these adverse scenarios appropriately, it is necessary to recognize that with higher losses more retro premiums will be collected than what is anticipated by the held retro premium reserve.

In our analysis, we reflect additional retro premiums (above the held reserve level) in the following way:

a. First, we separately identify how much of Auto, GL, and Workers' compensation loss reserves are associated with retro policies.
b. We assume that the loss payment pattern is the same for both guaranteed cost and retrospectively rated business, and that adverse loss payments in each runoff year are split in the same proportion as the original reserves.
c. For each runoff year, we associate the marginal amount of increased loss payments with a marginal increase in reported case reserves. We produce the case reserve increase by assuming that the case reserves will anticipate the future adverse loss payments for a specified "horizon" (i.e. a specified number of future years)[5].
d. For each runoff year, the product of the marginal increase in reported case reserves and a retrospective premium "responsiveness" factor (developed through a separate review of the retrospective premium reserve) produces the additional retro premium received. The responsiveness factor is a ratio representing the expected additional premiums per dollar of additional reported loss. The factor incorporates, in aggregate, the individual characteristics of all our retrospectively rated accounts, e.g. specified aggregate loss limitations of the insured ("maximums" on the retro contract).

Via an interpolation formula in our cash flow spreadsheet, we cause the responsiveness factor to vary inversely with the severity of the loss

[5]In other words, the shocked reserves of year X = base case reserves of year X plus the future increase in payments due to the shock over the next Y years. The choice of Y allows for a gradual recognition of the shock in the reserves.

development scenario. This reflects the fact that at higher levels of loss development, more insureds will reach their maximums and so the additional retro premiums received will diminish in relation to the amount of additional losses.

As mentioned earlier, we show the additional retro premiums received as offsets to the loss payments (i.e. negative outflows).

LOSS DEVELOPMENT

Our base case projected loss and loss adjustment expense payments are produced by multiplying the held reserve levels by a reserve payout pattern[6]. These payout patterns are developed in a separate analysis and are in Annual Statement Schedule P line detail.

We will briefly describe one algorithm that can be used to produce loss payments given a targeted adverse loss development scenario. However, it is worth noting that there is no one "right" way to do this. This method should be viewed as appropriate for a "plain vanilla" type of analysis where the primary objective is to mechanically vary loss payments, in both amount and timing, over a range of scenarios. The easiest way to describe the algorithm is with a few formulas:

Let "Held" represent the held loss and loss adjustment expense reserve and p_i, $i = 1, \ldots, n$ represent the base loss and loss adjustment expense payout (n runoff years). Then

$$\text{Held} = \Sigma\, p_i \qquad i = 1, \ldots, n$$

[6] There are some components of the held reserve that are excluded because no reasonable base payout pattern can be developed.

Let "Target" be the targeted development scenario (for example, if the scenario represents projected loss payments exceeding the held reserves by 10%, then Target = 1.1 x Held). For each runoff year, assume that the payments under the adverse scenario are related to the base scenario by a constant factor raised to a power, where the power is the index of the runoff year. Then:

$$\text{Target} = \Sigma\, p_i \times c^i \qquad i = 1, \ldots, n \qquad \text{or}$$

$$\Sigma\, p_i \times c^i - \text{Target} = 0 \qquad i = 1, \ldots, n$$

The second expression is just a polynomial of degree n that can be solved using Newton's method[7] (where the unknown is c). Use of the exponential relationship lengthens the payout pattern relative to the base pattern, but this may be a reasonable way to model the adverse payments (one could take the view there is relatively more uncertainty associated with the projected payments far out into the future than with the projected payments in the nearer years). Note, however, that most of the dollars of development will still occur early on in the runoff[8] because the volume of loss payments is so much greater in these years than the outer years.

At very high levels of development, and with long tailed lines of business, this method may put more development in the tail than is desired. To add more flexibility in controlling the timing of the additional loss payments, we have modified the above approach by breaking up the polynomial into two sections (Newton's method still applies). For earlier payments, the same expression is used, with the increasing exponent, up to a specified year. After the specified year, say runoff year m, the

[7]Newton's method is a numerical algorithm that solves for roots of the equation, F[x] = 0. It is part of the CAS, Part 3 examination syllabus.
[8]This will tend to be true for all but the most extreme levels of targeted development.

exponent is kept constant (e.g., $p_i \times c^m$, $i = m+1, \ldots, n$). This allows us to maintain the original pattern, or to vary the lengthening of the pattern anywhere between this (no change) and the full exponential approach.

There are some other details of our development procedure that we won't discuss here in the interest of being brief - for example, splitting the targeted overall development to line of business.

OTHER LIABILITIES

Unearned Premium Reserve

The unearned premium reserve reflects a commitment to provide loss coverage for a limited period following the balance sheet date. In our analysis, we reflect this future commitment by developing an expected combined ratio for the unexpired portion of currently "in force" business. The product of this combined ratio and the UPR, less prepaid expenses, produces the total future outflows associated with the UPR (there is a complication to this that will be discussed in the next paragraph). To get the cash flows, we apply a loss and loss adjustment expense payout pattern to the total loss amount, and assume that other expenses (again, excluding prepaid expense) are paid in the first runoff year. Note that the loss and loss adjustment expense payout pattern for the UPR should reflect that the loss exposure is not even over the UPR coverage period - i.e., the highest exposure is in the first quarter, and then it decreases in each future quarter. This shortens the payout pattern somewhat relative to an accident year pattern.

The method described above relies on the UPR to be an appropriate measure of the future loss exposure committed to as of the balance sheet date. However, this may not be true depending on how premiums are booked. For some of our commercial lines business, premium is accounted for on a "booked as billed" basis. This means that the amount of written premium that is booked depends on the billing arrangement of the policy and does not necessarily represent the full term premium of the policy. Likewise, the unearned premium reserve for the policy does not reflect the total future loss exposure on the policy[9]. Therefore, when we project the future outflows on the "UPR" we first adjust the UPR upward for these not yet booked or earned premiums. Note that these premiums also represent future cash inflow.

Finally, our model includes the capability to shock the future loss payments on the UPR according to the adverse (shocked) loss development scenario selected. This is done by runoff year by taking the ratio of shocked to unshocked loss payments on the loss reserves, and then applying this ratio to loss payments on the UPR (we just do this for all lines combined, not line by line).

Accrued Expense and Other Liabilities

This liability includes various accounts payable (including oustanding general expenses), funds held on account of others, and various accruals. For the "insurance" liabilities, all we do is assume that the balance sheet amount is paid in the first runoff year.

"Insurance" liabilities is highlighted because we actually perform our analysis on two separate balance sheets. One balance sheet includes only the insurance liabilities and only those assets supporting those liabilities (we maintain separate investment portfolios, one to support insurance liabilities, and one to support statutory surplus). The other balance sheet includes assets supporting surplus, plus several corporate liabilities such as accruals

[9] For example, suppose a $120 annual policy is billed in four quarterly installments, and the premium is booked as billed. Then the booked written premium at the beginning of each quarter is $30, and the associated unearned premium is $30. The balance sheet unearned premium reserve will not reflect the full loss exposure committed to under the policy.

for Post Retirement Benefits other than Pensions (OPEBs, FAS 106), and corporate debt. We will not discuss the development of these cash flows here except to say that OPEBs are of long duration.

Taxes

A detailed discussion of the appropriate way to reflect taxes is beyond the scope of this paper. Furthermore, in our analysis we have taken a somewhat "broad brush" approach to the tax question, and we feel this is reasonable in the context of the analysis intended use (as discussed below).

In most of our past analyses, we have ignored the effect of taxes. This is because the purpose of our analysis is to see if we can withstand extreme shock scenarios, not to forecast future expectations. We have always assumed that these shocks would be so severe that Federal Income Tax payments would be zero.

Recently, we have included a rough tax calculation in our model to evaluate the impact of taxes. This involves producing a calendar year taxable income base for each year of the runoff, and then calculating the incurred tax payable. This requires tracking any net operating loss carryforwards available to the company; splitting investment income to taxable vs. non-taxable components; tracking future investment income and losses from defaults; and tracking reserve runoffs, reserve strengthening and the associated tax loss reserve discount factors. We have not reflected any alternative minimum tax in the tax flows.

One significant question in modeling the timing of the tax flows is how to model the loss and loss adjustment expense reserve balances. As discussed earlier, our loss development method produces higher loss payments in the runoff years which in total equal a selected target development. The question is - at each runoff year end, to what extent do the loss reserves anticipate the future adverse loss payments (i.e., how is the reserve funded to meet the adverse loss payments)? Our approach has been to specify a certain "horizon" of future years adverse loss payments that the reserve responds to (for example, shocked year i reserve = unshocked year i reserve + shock payments for the next j years). The number of years in the horizon can be varied but we have usually assumed 3-5 years.

PRESENTATION TECHNIQUES

Over the years, presentation techniques for the analysis results have of course varied. However, the intended message is always focused on the company's current ability to pay claims, and that only a cash flow analysis of this type can truly measure this ability.

Furthermore, we have always focused first on this financial strength using only those assets supporting our reserves (we begin with assets equal to insurance liabilities - statutory basis, i.e., no surplus included). In this way, we "uncover" our balance sheet financial strength, showing our ability to meet adversity without drawing on existing company surplus. We believe that this makes the message even stronger.

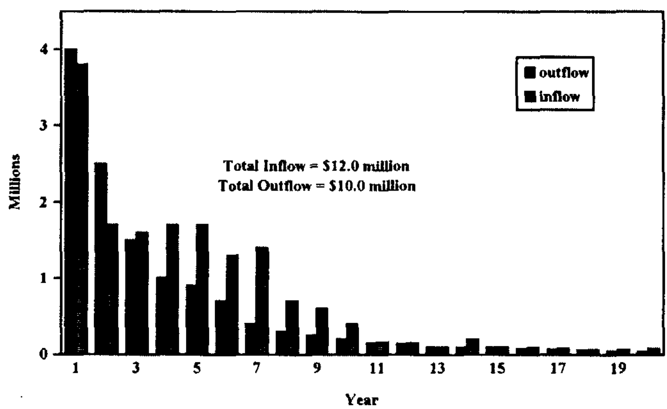
Getting the message across requires the use of various measures that quantify this financial strength. We have used amounts of nominal net cash flow, cash flow net present value, and internal rate of return. These have been combined in various matrix formats to try to get at the various combinations of interest rate, asset default and reserve development risks that have been evaluated. As expected, the simplest formats are those that are most consistently well received.

Nominal Net Cash Flows

We have found that presentation of the nominal cash flows - asset inflows, liability outflows, net flow - is an effective way of communicating the idea of the financial strength available to meet company obligations. What this can show, for balance sheet assets and liabilities, is the amount by which expected asset cash flows exceed expected liability cash flows. This excess cash flow would be available to help manage the possibility of future adverse experience, or if this did not occur, would emerge as profit.

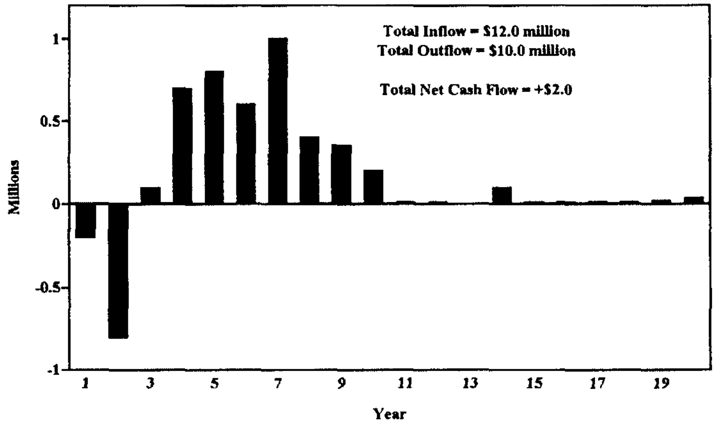
Figure 1 below is an example of a graph we have used to show both the total amounts of the flows, and the timing of the flows:

Runoff Cash Flow by Year



The graph of the net flow, inflow - outflow, is also one that we have used frequently (shown below). This graph highlights the years with negative cash flows (bars extending below the horizontal axis) vs. years with positive cash flows (bars extending above the horizontal axis).

Net Cash Flow by Year



These graphs have the advantage that they give an easy to understand result. However, in certain situations they have a disadvantage in that they do not provide a single number "sound bite".

Present Value

Cash flow present values are also an important measure used in our analysis. These have really been used in two different ways, depending on what the circumstances have been.

First, for our cash flow report we have included present values for many shock scenarios including the "boundary" scenarios (where the present value of the net cash flow equals zero). In the report, we focus on the range of answers and not the results of any one scenario.

Second is the situation where we have needed to convey the message of financial strength quickly in one or two slides or exhibits, say for a presentation. Under these circumstances, talking about a multitude of scenarios distracts from the main point which is the balance sheet financial strength. Therefore, in this situation, we have presented results for a single scenario, our base case scenario. In this context, the net cash flow present value has the advantage of being easy to quote (since it is just one number it makes a better "sound bite"). However, a disadvantage of using the present value is that the number itself can actually draw attention away from the main message of financial strength. Questions to us have varied but have included: Is this a market value?; Is the discount rate before or after tax?; What is the assumed borrowing vs. reinvestment rate?; etc., etc.

Fundamentally, what it comes down to is the difficulty in choosing a discount rate for the present value calculation that everyone feels is appropriate. A possible solution is to present the answer as "the present value at x% = y", and be ready with several other answers at different discount rates if needed.

Internal Rate of Return

Like the present value, the internal rate of return ("IRR") has the advantage of being easy to quote. In addition, using the IRR avoids the argument over what discount rate to use, and it communicates well to investment people.

Disadvantages of the IRR are that it is not easily understood by non-investment people, and that it provides less information than the nominal flows. One misinterpretation that we have occasionally seen is the characterization of the IRR as the "highest" rate that the asset cash flows can withstand and still be sufficient to meet the liability cash flows. This is true only for <u>constant</u> interest rate scenarios. Finally, sometimes the IRR does not exist (or is "infinite", whatever that means).

In our cash flow report, we have used the internal rate of return ("IRR") to provide the "border" interest rate (i.e., present value = 0, for a given combination of asset default and reserve development assumptions). However, we have generally focused more on the changes in the IRR from year to year. Usually, if the IRR does change significantly this is a signal to us to do more work to understand why the change occurred (sometimes uncovering data problems).

Generally, we have limited the use of the IRR to our own analytical purposes, and to special situations where the audience is already familiar with the IRR.

APPENDIX A.

1. From Schedule D, Part 1A, schedule out the amount of bond principal still outstanding by year, by rating. For example, class 1 Bonds outstanding in year 5 include bonds maturing in years 6 - 10, 10 - 20, and over 20 years.[10] Government bonds were pulled out as if they were a separate rating group, as we assume they have a 0% default rate.

2. The annual statement shows bonds by NAIC classes 1-6. Default rates instead come in rating groups AAA through B. This requires a translation of the above data by NAIC class into default table rating groups.

   Classes 2 through 4 translate directly into specific ratings (BBB, BB and B). Class 1, containing AAA though A, was translated into a rating of AA[11]. Classes 5 and 6 were grouped with those rated B. (This may distort the final answer for a company with significant class 5 and 6 bonds due to the very high default rates for these bonds, although this is minimized due to NAIC rules restricting these investments).[12]

3. Translate the cumulative default probabilities from the default table into incremental default probabilities.

[10]Schedule D, Part 1A includes bonds by broad maturity ranges: 1 or less, 2 - 5, 6 - 10, 11-20, over 20. We translate these ranges into maturity years of 1, 3, 7, 15 and 25. Only the first 20 years were used, however, as default rates are not published beyond 20 lag years.
[11]This has minimal impact, as default rates in the tables vary little between these three classes.
[12]An additional problem exists in that bonds below class 2 (rating BBB, which is the lowest rating for investment grade bonds) are carried at market in the annual statement. Therefore Schedule D, Part 1A would tend to underestimate the level of lower rated bonds in the pre-default bond cash flows. This bias would be hidden where coupon rates are above current yields, and exacerbated when coupon rates are below current yields.

4. Apply these incremental default probabilities by rating and lag year against outstanding bonds by rating and default year to get default rates by year.

NUMERICAL EXAMPLE OF DEFAULT RATE CALCULATION

Steps 1 &2: Schedule out amount of bond principal outstanding, by year, by rating.

Excerpt from Schedule D, Part 1A[13]
Quality and Maturity Distribution of Bonds

	<1 YR	1-5 Yrs	5-10Yrs	10-20Yrs	>20Yrs	Total
			...			
Class 1	27,034	56,306	77,989	80,790	32,173	274,291
			...			

Assumed Oustanding Principal of Bonds by Rating Group

	Year 1	2	3	4	...	Assumed Ratings
Gov't	138,954	122,347	122,347	66,418		
AAA						
AA	274,291	247,258	247,258	190,952	...	**Class 1**
A						
BBB	27,864	24,906	24,906	18,090		**Class 2**
BB	3,455	3,246	3,246	2,460		**Class 3**
B or Lower	2,701	2,539	2,539	1,974		**Classes 4,5, and 6**
Total	446,905	400,296	400,296	279,894		

a. Class 1 bonds are assumed to be AA;

b. Beginning year 1 outstanding ("O/S") is total Class 1 principal; Beginning year 2 O/S = year 1 O/S, minus year 1 maturities; Beginning year 4 O/S =

[13]Using 1994 Best's Aggregates & Averages.

year 3 O/S, minus 1-5 year maturities (assuming principal matures at the midpoints of the intervals, e.g., 3.5 years for the 1-5 year maturities); etc.

Step 3: Translate cumulative default probabilities to incremental default probabilities:

e.g. Cumulative AA default rate at 3 and 4 years equals .001 and .002[14] respectively; therefore incremental default rate for year 4 is: (.002 - .001)/(1 - .001) = .001

Incremental Default Assumptions[2]

	Year 1	2	3	4	...
AAA	0.0%	0.0%	0.0%	0.0%	
AA	0.0%	0.0%	0.1%	0.1%	
A	0.0%	0.1%	0.2%	0.2%	
BBB	0.2%	0.3%	0.4%	0.6%	
BB	1.8%	2.6%	2.6%	2.7%	
B or Lower	8.3%	7.1%	6.6%	5.5%	

Step 4: Weight incremental default rates by rating and lag year against oustanding bond principal by rating and lag year to get average default rates by year:

Average Default Rates

	Year 1	2	3	4	...
All Rating Groups	0.08%	0.09%	0.15%	0.17%	etc.

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[14]A Table of cumulative default rates is published annually by Moody's Investors Service. To get the incremental rates from the cumulative default table, one must take the conditional probability of default in year n, given that default does not occur before year n. If C(n) is the cumulative default rate through year n, then the incremental default rate is [C(n) - C(n-1)]/[1 - C(n-1)].

NOTE: The authors thank John V. Mulhall for his help in creating these examples.

BIBLIOGRAPHY

[1] Altman, Edward, "Default Risk, Mortality Rates, and the Performance of Corporate Bonds", The Research Foundation of the Institute of Chartered Financial Analysts, 1989.

[2] Moody's Investors Service, "Corporate Bond Defaults and Default Rates", January 1994, Page 19.

[3] Fabozzi, Frank, "The Handbook of Fixed Income Securities", Business One Irwin, 1991, Page 27.

[4] Hu, Joseph, "The Evolution of Mortgage Research", Mortgage Banking, January 1990, Page 35.